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Volume 22, Algorithm Updates for the Fourth SeaWiFS Data Reprocessing

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Chapter 2

Changes to the On-Orbit Calibration of SeaWiFS

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Abstract

Monthly lunar calibrations and daily solar calibrations are used to track the on-orbit stability of the radiometric calibration of the SeaWiFS instrument. Analyses of these data by the SeaWiFS CVT since the third reprocessing showed residual errors in the detector temperature corrections, the lunar calibration time corrections, and the mirror side reflectance corrections. These analyses, and the resulting changes to the on-orbit calibration methodologies, are presented in this chapter. Revised detector temperature corrections allowed the lunar calibration time series to be characterized by a single, time-dependent exponential function. A time correction was applied to the normalization of the lunar calibration time series; time-dependent mirror side reflectance corrections were also implemented. These changes to the calibration methodologies enabled the production of a more robust on-orbit calibration of SeaWiFS for the fourth reprocessing of the SeaWiFS mission data set.

2.1 INTRODUCTION

The SeaWiFS CVT undertook extensive analyses of the SeaWiFS on-orbit calibration data and ocean data in preparation for the fourth reprocessing of the mission data set. These analyses showed three sources of residual errors in the on-orbit calibration data: a) an annual periodicity in the lunar calibration time series for some bands, b) a residual time drift in the lunar calibration data, and c) a change in the half-angle mirror side reflectances with time. A number of changes were implemented to the on-orbit calibration methodologies to address these residuals. These changes, which have resulted in a more robust on-orbit calibration of SeaWiFS, are detailed in the following sections of this chapter.

2.2 TEMPERATURE CORRECTION

The ambient temperatures at which the SeaWiFS detectors operate are affected by the solar insolation on the spacecraft. The SeaWiFS calibration incorporates corrections for variations in the radiometric response of the instrument with changing detector temperatures (Barnes et al. 1994). The prelaunch corrections do not fully account for the variation in radiometric response with changing detector temperatures observed over the course of a year. Examination of the SeaWiFS lunar calibration time series (Fig. 1) shows an annual periodicity in some bands which corresponds to the variation in detector temperatures (Fig. 2) as the Earth–sun distance changes over a year. Through the third reprocessing, the CVT dealt with these annual periodicities with a series of piecewise quadratic and linear segments in the time correction applied to the ocean data (Barnes et al. 2001 and Eplee and Barnes 2000). This approach required regular updates to the operational calibration table.

For the fourth reprocessing, the periodicities in the lunar time series were used to compute revised detector temperature correction factors for the SeaWiFS calibration. The SeaWiFS level-1b calibration equation includes a correction for variations in the radiometric response of the detectors as a function of temperature, f_T (Eplee and Barnes 2000). This correction has the form

$$f_T(\lambda) \;=\; 1 \;+\; K_2(\lambda)(T - T_{\mathrm{ref}}), \tag{1}$$

where λ is the wavelength, K_2 is the temperature correction factor, T is the detector temperature from the sensor output data, and T_{ref} is the detector reference temperature (20°C).

During the prelaunch calibration of SeaWiFS, the temperature correction factors were derived for each band over a limited range of detector temperatures. These values are shown in Table 2. To investigate the periodicities in the lunar calibration time series, each band in the time series was fit to a decaying exponential function of time. The residuals of these fits showed linear dependencies on detector temperature.